International Research Journal on Advanced Engineering and Management
https://goldncloudpublications.com
https://doi.org/10.47392/IRJAEM.2025.0228
e ISSN: 2584-2854
Volume: 03
Issue: 04 April 2025
Page No: 1403 - 1406

Improving Science Process Skills Among Pre-Service Trainees Through Hands-On Experiments

Parthiban J[1], Dr. Leo Stanly S[2]
[1]Research Scholar, Department of Education (CDOE), Centre for Distance and Online Education (CDOE), Alagappa University, Karaikudi-630003, Tamilnadu, India
[2]Professor, Department of Education Centre for Distance and Online Education (CDOE), Alagappa University, Karaikudi -630003 Tamilnadu, India
Email ID: *jparthi78@gmail.com[1], leostanlys@alagappauniversity.ac.in[2]*

Abstract
The study was driven by the investigator's dissatisfaction with the traditional lecture and demonstration methods which were ineffective in developing essential skills such as observing, classifying, measuring, inferring, experimenting, and communicating. The researcher identified key challenges including a lack of hands-on activities and insufficient feedback. To address these a three-month intervention was implemented involving 20 pre-service trainees. The intervention featured structured hands-on experiments in Chemistry, Physics and Biology integrated with inquiry-driven learning and meaningful feedback. Data was collected using pre- and post-intervention questionnaires. The results showed significant improvements in all targeted skills with gains of 44% in observing, 43% in classifying, 38% in measuring, 35% in inferring, and 31% each in experimenting and communicating. The study concludes that hands-on experiments significantly improve science process skills among pre-service trainees. These findings offer practical implications for educators seeking to improve science teaching methodologies in teacher education programmers.
Keywords: *Science process skills, Pre-service Trainees, Hands-on Experiments.*

1. Introduction
Developing science process skills is a fundamental objective of science education especially in teacher training institutions where future educators are prepared to foster scientific thinking in classrooms. Science process skills such as observing, classifying, measuring, inferring, experimenting, and communicating form the foundation for scientific inquiry and problem-solving. However, despite its importance, many pre-service trainees struggle to acquire these essential skills through conventional lecture-based instruction. This research emerged from that need for change. The investigation sought to identify the root causes of ineffective skill development which included limited exposure to hands-on practice and minimal feedback, and inadequate opportunities for experiential learning. The research aimed to design and implement a more effective strategy that integrated hands-on experiments and continuous feedback. By focusing on practical experimentation in Chemistry, Physics, and Biology, the intervention targeted the holistic development of science process skills among pre-service trainees. This study was not only addressed a critical gap in science education but also offers insights into effective pedagogical approaches that can be adopted across similar educational settings [3-10].

2. Need and Significance of The Study
Science process skills are the foundational tools that enable learners to think scientifically, investigate problems, and construct knowledge based on evidence. In the context of teacher education, cultivating these skills in pre-service trainees is vital, as they are future facilitators of science learning in classrooms. However, traditional teaching methods, such as lectures and limited demonstrations, often fall short in actively engaging learners in the scientific process was observed that a considerable number of pre-service trainees struggled to grasp and apply science process skills effectively. This gap was

International Research Journal on Advanced Engineering and Management
https://goldncloudpublications.com
https://doi.org/10.47392/IRJAEM.2025.0228
e ISSN: 2584-2854
Volume: 03
Issue: 04 April 2025
Page No: 1403 - 1406

especially evident in their inability to perform core scientific tasks such as making accurate observations, classifying information, conducting measurements, inferring results, designing experiments, and communicating findings. The deficiency was not only hindered their academic development but also posed challenges in preparing them as competent science educators. This study was therefore necessary to address these shortcomings by redesigning the existing teaching strategies. The action research aimed to integrate hands-on experimentation and timely feedback into the instructional process. The significance of this research lies in its potential to transform passive learning into active engagement, thereby improving both conceptual understanding and scientific thinking [1][2].

3. Methodology

3.1 Sample of The Study

The present study employed a purposive sampling technique to select the sample from the population. The investigator collected data from 20 pre-service trainees from DIET, Padalur and BITE, Veppur in Perambalur district were used as the sample for the present investigation.

3.2 Objectives of The Study

- To Know the level of knowledge in science process skills.
- To understand the science process skills among the pre service trainees.
- To assess the effectiveness of the hands-on experiments through pre and post-intervention evaluations.

3.3 Hypotheses of The Study

The level of knowledge in science process is low

There is no significant difference in the science process skills of pre-service trainees in pre- and post-intervention evaluations of hands-on experiments.

4. Result and Discussion

4.1 Hypothesis

The level of knowledge in science process skill the pre service trainees is low

Table 1 Process Skill Achievement

S.NO	Science Process Skill	Pre-Test Score	Post-Test Score	Improvement
1	Observing	50%	94%	44%
2	Classifying	46%	89%	43%
3	Measuring	54%	92%	38%
4	Inferring	38%	73%	35%
5	Experimenting	40%	94%	54%
6	Communicating	50%	95%	45%

The above table shows that the level of knowledge in science process skills have significant improvement in Observation 44%, Classifying 43%, Measuring 38%, Inferring 35%, Experimenting 54% and Communicating 45%. Hence it is proved that the knowledge of science process skill among pre service trainees is high. Table 1 shows Process Skill Achievement.

4.2 Hypothesis 2

There is no significant difference in the science process skills of pre-service trainees in pre and post intervention evaluations of hands-on experiments.

Table 2 Pre-Test and Post Test Scores of Pre-Service Trainees

Test	N	Mean	SD	T test	Level of Significance
Pre test	20	5.2	0.75	23.38	S
Post test	20	9.2	0.78		

International Research Journal on Advanced Engineering and Management
https://goldncloudpublications.com
https://doi.org/10.47392/IRJAEM.2025.0228
e ISSN: 2584-2854
Volume: 03
Issue: 04 April 2025
Page No: 1403 - 1406

The difference between pre-test (5.2) and post-test (9.2) scores is statistically significant ($t(19) \approx 23.38$, $p < 0.0001$), indicating a meaningful improvement after the intervention. Table 2 shows Pre-Test and Post Test Scores of Pre-Service Trainees.

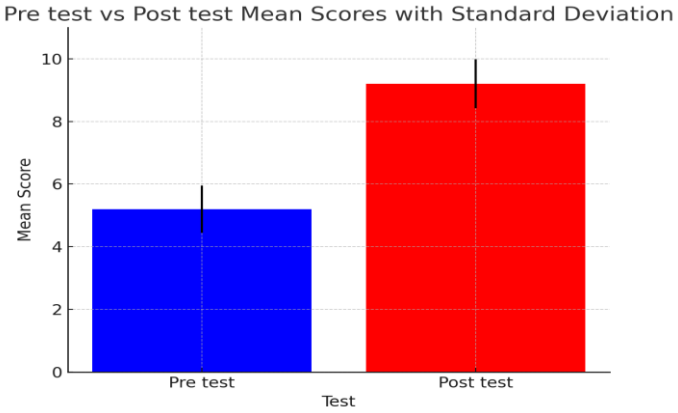

Figure 1 Pre-Test Vs Post Test Score with Standard Deviation

4.3 Education Implications

These results carry critical implications for teacher education programs. Firstly, integrating structured hands-on science activities should be a core element of pre-service training curricula. Secondly, consistent and constructive feedback mechanisms must be embedded within instructional strategies to promote reflection and reinforce learning. Thirdly, educators must shift from passive teaching methods to more engaging, learner-cantered approaches that foster scientific inquiry and critical thinking [11-16]. By equipping future educators with practical experience in conducting and analyzing scientific experiments, this research contributes to build a more competent and confident teaching workforce. To enhance process skills will likely influence their classroom practices, potentially improving science education outcomes for future generations of students. Figure 1 shows Pre-Test Vs Post Test Score with Standard Deviation.

Conclusion

The findings of the study provide compelling evidence for the effectiveness of hands-on experimental learning in improving science process skills among pre-service trainees. The substantial gains across all six core skills observing (44%), classifying (43%), measuring (38%), inferring (35%), experimenting (54%), and communicating (45%) highlight the transformative potential of experiential learning methodologies when compared to traditional lecture-based instruction. The mean score of pre and post test score varies from 5.2 to 9.2 so this study indicates that the hands-on experimentation as effective tools for developing science process skills.

References

[1]. Parthiban, J., & Leo Stanly, S., (2025). Enhancing chemistry process skills in ninth-grade students through infographic video modules. Paripex - Indian Journal of Research, 14(3), 5. https://doi.org/10.36106/paripex

[2]. Parthiban, J., & Leo Stanly, S., (2024). Enhancing the science process skills through Phet simulation. International Research Journal on Advanced Engineering and Management, 2(3), 432–435. https://doi.org/10.47392/IRJAEM.2024.0060

[3]. Chakraborty, D., & Gillian, K. (2021). Inquiry process skills in primary science textbooks: Authors and publishers' intentions. Research in Science Education, 52, 1419-1433.

[4]. Cairoli, U., Guven, O., & Saylan, E. (2020). Flipping the experimentation process: Influences on science process skills. Education Technology Research Development, 68(6), 3425-3448.

[5]. Ekici, M., & Erdem, M. (2020). Developing science process skills through mobile scientific inquiry. Thinking Skills and Creativity, 36, 1-12.

[6]. Elkeey, S.S. (2017). Developing science process skills and some of accompanying skills through observation of life cycle of silkworm by kindergarten child. The Online Journal of New Horizons in Education, 7(1), 53-63.

[7]. Llewellyn, D. (2013). Teaching high school science through inquiry and argumentation (2nd ed.). Corwin Press.

International Research Journal on Advanced Engineering and Management
https://goldncloudpublications.com
https://doi.org/10.47392/IRJAEM.2025.0228
e ISSN: 2584-2854
Volume: 03
Issue: 04 April 2025
Page No: 1403 - 1406

[8]. Ergul, R., Sımsekli, Y., Calis, S., Ozdilek, Z., Gocmencelebi, S., & Sanli, M. (2011). The effects of inquiry-based science teaching on elementary school students' science process skills and science attitudes. Bulgarian Journal of Science and Education Policy, 5(1), 48-68.

[9]. Hofstein, A., & Lunetta, V. N. (2004). The laboratory in science education: Foundations for the twenty-first century. Science Education, 88(1), 28–54. https://doi.org/10.1002/sce.10106

[10]. Mayer, R. E. (2004). Should there be a three-strikes rule against pure discovery learning? The case for guided methods of instruction. American Psychologist,59(1),14–19. https://doi.org/10.1037/0003-066X.59.1.14

[11]. Colvill, M., & Pattie, I. (2002). Science process skills: Their nature and interrelationships. Research in Science & Technological Education, 20(1), 51–63. https://doi.org/10.1080/0263514022013096 3

[12]. Bybee, R. W. (2000). Teaching science as inquiry. In J. Minstrell & E. H. van Zee (Eds.), Inquiring into inquiry learning and teaching in science (pp. 20–46). American Association for the Advancement of Science.

[13]. Harlen, W. (1999). Purposes and procedures for assessing science process skills. Assessment in Education: Principles, Policy & Practice, 6(1), 129–144. https://doi.org/10.1080/09695949993044

[14]. National Research Council. (1996). National science education standards. National Academy Press. https://doi.org/10.17226/4962

[15]. Tamir, P. (1983). Inquiry and the science teacher. Science Education, 67(5), 657–672. https://doi.org/10.1002/sce.3730670511

[16]. Haury, D. L., & Rillero, P. (1994). Perspectives of hands-on science teaching. ERIC/CSMEEDigest.ERICNumber: ED372926https://files.eric.ed.gov/fulltext/E D372926.pdf